

Project Screw-Worm

Predesign Concepts for
The Rearing of 50 Million Flies Per Week

Addendum No. 1 to ENCR-9
An Analysis on the Modified Larvae Rearing Step
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AN ANALYSIS OF THE MODIFIED LARVAE REARING STEP AS
PERFORMED AT THE BITHLO PILOT PLANT IN OCTOBER 1956

Summary

The modified process consists of rearing 100,000 larvae on a large metal tray (120" x 54") containing a less moist medium than used in the small tray (17" x 25") process design. The temperature ($37^{\circ}\text{C.} \pm 2^{\circ}$) during rearing is maintained by a bank of incandescent lamps mounted below the tray. This permits heating of the medium from the bottom and simulates field conditions more than the original process in which the top surface of the medium was exposed to humidified air. This modified process was observed and data compiled by C.E. Cottrell, Jr. on a visit to the Bithlo Pilot Plant on October 31, 1956. The brief process description and analysis presented below are based on these observations.

Process Description

A small amount of medium is initially placed along the long edge of the tray and maintained in-bounds by a half-inch high barrier placed lengthwise forming a section 12" x 10 feet. The new medium consists of:

Meat, ground	15 lb.
Blood, bovine	2 liters
Water	4 liters
Formalin	30 cc.

The heating system is put into operation and 10 grams of freshly-laid eggs, (20 eggs per mgm, totalling 200,000 eggs), are distributed over the medium. This step takes approximately 15 minutes by the technician, using a pump and hose for adding the medium and appropriate equipment for the distribution of the eggs. No attention is required for 48 hours during which time the eggs hatch into tiny larvae. These larvae group together in pockets during their growth moving over to fresh medium as it becomes utilized.

On about the 48th hour, twice the original quantity of medium is flooded over the tiny larvae. The medium floods over the barrier and stops at the lengthwise placed board forming a section 24" by 10 feet. This requires 20 minutes of the technician's time and needs no attention for the next 24 hours.

Process Description (continued)

At the end of the third day (72 hours), the larvae are moved over two more feet and three times the original amount of medium is added alongside the growing larvae. This step takes the technician 30 minutes and is left alone for 24 more hours.

At the end of the 4th day, the waste medium from the first two days of growth is scooped out and discarded. Six times the original quantity is distributed over the entire tray and left without attention for 36 hours. The technician takes about 40 minutes to perform this step. During the last portion of this incubation time, the larvae begin to crawl out of the medium to the edge of the tray seeking dry, dark, and firm conditions. They fall into troughs around the edge of the tray and through a small duct leading into a suitable box containing sand.

Discussion

The advantages of the modified system include the growth of the larger larvae and labor savings in handling of the medium on a pilot plant scale. A preliminary analysis shows that about 2 hours of direct labor are required to raise 100,000 larvae for this step. For a rate of a million flies per week, this step would require about 20 man hours compared to approximately 40-100 man hours using the small tray as previously experienced in the Bithlo Pilot Plant. It has been calculated that about 20 man hours per million flies will also be required for the designed process of 5 million flies per week.

The gain by this modified method seems to be lost upon analysis of the medium utilization. Approximately 53% more meat was used adding \$0.1371 to the cost of 1,000 flies assuming all other conditions similar to the reported process. The details of this analysis are found in Table I. This would add about \$ 700,000 to the total cost over a two year period. However, it is realized that further economies will be made by improving the efficiency of the medium utilization to where it would be comparable to the small tray method. The primary objective of the experiment was to observe the technique of growth in the larger tray.

Discussion (continued)

Assuming that the medium costs are the same by both processes, it would be necessary to stack the larger tray at least five high in order not to add to the construction cost of the building. How this would be accomplished has not been established as yet. Problems such as heating from underneath, cleaning of trays, removal of waste medium, location of pupation boxes and odor removal would need to be studied and resolved. Additional process lines (medium, waste water, hot water) would need to be piped into the incubator room. An analysis of the floor occupancy by the modified method as compared with the design of the original process is included in Table II.

Comparison of the material consumption by the originally designed process with the modified process. The table is arranged in the following order: 1. Original process, 2. Modified process, 3. Difference.

Original		Modified		Difference	
Material	Quantity	Material	Quantity	Material	Quantity
Tray	1.00	Tray	1.00	Tray	0.00
Medium	1.00	Medium	1.00	Medium	0.00
Water	1.00	Water	1.00	Water	0.00
Electricity	1.00	Electricity	1.00	Electricity	0.00
Heat	1.00	Heat	1.00	Heat	0.00
Light	1.00	Light	1.00	Light	0.00
Odor	1.00	Odor	1.00	Odor	0.00
Waste	1.00	Waste	1.00	Waste	0.00
Construction	1.00	Construction	1.00	Construction	0.00
Equipment	1.00	Equipment	1.00	Equipment	0.00
Personnel	1.00	Personnel	1.00	Personnel	0.00
Total	10.00	Total	10.00	Total	0.00

Reference is made to the materials in the original process which are higher by the modified process.

Assuming that the waste water is removed by the original process, it would be necessary to pump the waste water to the outside of the building. This would be accomplished by a pump system. The original process has not been established as yet. Problems such as heating from underneath, cleaning of trays, removal of waste water, location of pupae cases and other removal would need to be studied and removed. Additional process lines (waste water, waste water) would need to be piped into the building. In summary, the floor occupancy by the modified process is compared with the design of the original process is included in Table I.

TABLE I

Comparison of raw material consumption by the originally designed process with the modified process.

Original					
	Per tray = 17" x 25" = 2.95 ft ² 4800 pupae	Per ft ²	Per 1000 pupae	Per 1000 flies	Cost/ 1000 flies
Meat	2400 cc = 5.57 lb	1.89 lb	1.16 lb	1.25 lb	\$0.2488
Blood	1200 cc = 2.82 lb	0.96 lb	0.59 lb	0.63 lb	0.0093
Water	2400 cc = 5.31 lb	1.80 lb	1.11 lb	1.19 lb	-
Formalin	12 cc	4 cc	2.5 cc	2.7 cc	<u>0.0004</u> \$0.2585

TABLE I

Comparison of raw material consumption by the originally designed process with the modified process.

Modified		Per 1000 pupae	Per 1000 flies	Cost/ 1000 flies
Per tray 10' x 54" = 45 ft ² = 100,000 pupae	Per ft ²			
Meat	15/30/45/90 = 180 lb	4.0 lb	1.80 lb	1.93 lb
Blood	2/4/6/12 = 24 lit = 56.4 lb	1.25 lb	0.56 lb	0.60 lb
Water	4/8/16/24 = 48 lit = 106 lb	2.35 lb	1.06 lb	1.14 lb
Formalin	30/60/90/ 180 = 360 cc	8 cc	3.6 cc	3.9 cc
				<u>0.0006</u> \$0.3956

Difference in cost of raw materials is \$0.1371/1000 flies or 53% higher by the modified process.

TABLE II

Comparison of occupancy at 50,000,000 flies per week level

In incubator room only

	<u>Original*</u>	<u>Modified</u>
Size of tray	17" x 25"	54" x 120"
Area of tray, ft ²	2.95	45
No. of eggs per tray	6300	200,000
Yield %, eggs to mature larvae	95/80 = 75	50
Yield per tray, mature larvae	4800	100,000
Yield per ft ² of tray, mature larvae	1630	2210
Yield per area, advantage		4 35%
No. of larvae in process	43,000,000	43,000,000
No. of mature larvae, equivalent	34,500,000	34,500,000
No. of trays	7,200	345
Total tray space, ft ²	21,200	15,500
Floor space, ft ²	7,500	7,500
No. of trays per stack	15	5
Tray occupancy of floor space, %	19	41
Production per week, mature larvae	53,700,000	53,700,000
Production/week/ft ² floor area, larvae	7,130	7,130

*As described in ENCR No. 9 "Project Screw-Worm Predesign Concepts for the Rearing of 50 Million Flies Per Week.

Conclusions

Based on this brief analysis of the process presently being investigated at Bithlo, the method probably has advantages over the tray system on a pilot plant scale. However, in production, the handling, processing, ventilation, and cleanliness in a large stationary tray system creates problems not associated with the conveyed-tray system. It is assumed that the cost of medium per 1000 flies by the modified method will eventually be equal to that for the original process. Larger larvae and less odor problem due to underside heating seem to be the most promising advantages of the modified process. It is felt that these ideas might possibly be incorporated in the original design by the use of electrically heated glass shelves and aluminum trays. These trays could be recovered and credited to the process.

